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PROCEEDINGS
OF
THE ROYAL SOCIETY.

1834-1835.

No. 19.

December 18, 1834.

SIR BENJAMIN COLLINS BRODIE, Bart., Vice-President, in
the Chair.

The Rev. John Barlow, M.A.; Rev. James William Bellamy, B.D.; William Brockedon, Esq.; Thomas Galloway, Esq., M.A.; Bisset Hawkins, M.D.; Col. Andrew Leith Hay, K.H., M.P.; Francis Kiernan, Esq.; George Lowe, Esq.; Richard Owen, Esq.; Benjamin Phillips, Esq.; Richard Saumarez, Esq.; Charles John Kemys Tynte, Esq., M.P.; and John Gardnor Williamson, Esq.; were elected Fellows of the Society.

The reading of a paper, entitled, "On the Proofs of a gradual Rising of the Land in certain parts of Sweden." By Charles Lyell, Esq., F.R.S., was resumed, but not concluded.

January 8, 1835.

The REV. PHILIP JENNINGS, D.D., Vice-President, in the Chair.

On the Proofs of a gradual Rising of the Land in certain parts of Sweden. By Charles Lyell, Esq., F.R.S.

An opinion has long been entertained that the waters of the Baltic and even of the whole Northern Ocean, have been gradually sinking; and the purport of the present paper is, to communicate the observations which the author made during the summer of 1834, in reference to this curious question. In his way to Sweden he examined the eastern shores of the Danish islands of Moën and Seeland, but neither there, nor in Scania, could he discover any indications of a recent rising of the land; nor was there any tradition giving support to such a supposition. The first place he visited, where any elevation of land had been suspected, was Calmar; the fortress of which, built in the year 1030, appeared, on examination, to have had its foundations originally laid below the level of the sea, although they are now situated nearly two feet above the present level of the Baltic. Part of the moat on one side of the castle, which is believed to have been formerly filled with water from the sea, is now dry, and the bottom covered with green turf. At Stockholm, the author found many striking geological proofs of a change in the relative level of the sea and land, since the period when the Baltic has been inhabited by the

Testacea which it now contains. A great abundance of shells of the same species were met with in strata of loam, &c., at various heights, from 30 to 90 feet above the level of the Baltic. They consist chiefly of the *Cardium edule*, the *Tellina baltica*, and the *Littorina littoreus*; together with portions of the *Mytilus edulis*, generally decomposed, but often recognisable by the violet colour which they have imparted to the whole mass. In cutting a canal from Sodertelje to lake Maelar, several buried vessels were found; some apparently of great antiquity, from the circumstance of their containing no iron, the planks being fixed together by wooden nails. In another place, an anchor was dug up; as also, in one spot, some iron nails. The remains of a square wooden house were also discovered at the bottom of an excavation made for the canal, nearly at a level with the sea, but at a depth of 64 feet from the surface of the ground. An irregular ring of stones was found on the floor of this hut, having the appearance of a rude fire-place, and within it was a heap of charcoal and charred wood. On the outside of the ring was a heap of unburnt fir wood, broken up as for fuel; the dried needles of the fir and the bark of the branches being still preserved. The whole building was enveloped in fine sand.

The author next notices several circumstances regarding buildings in Stockholm and its suburbs, from which he infers that the elevation of the land, during the last three or four centuries, has not exceeded certain narrow limits. At Upsala he met with the usual indications of a former elevation of the sea, from the presence of littoral shells of the same species as those now found in the Baltic. Certain plants, as the *Glaucia maritima* and the *Triglochin maritimus*, which naturally inhabit salt marshes bordering the sea, flourish in a meadow to the south of Upsala; a fact which corroborates the supposition that the whole of the lake Maelar and the adjoining low lands have, at no very remote period of history, been covered with salt water.

The author examined minutely certain marks which had at different times been cut artificially in perpendicular rocks, washed by the sea, in various places; particularly near Oregrund, Gefle, Löfgrund, and Edskösund; all of which concur in showing that the level of the sea, when compared with the land, has very sensibly sunk. A similar conclusion was deduced from the observations made by the author on the opposite, or western coast of Sweden, between Uddevalla and Gotenburg; and especially from the indications presented by the islands of Orust, Gulholmen, and Marstrand.

Throughout the paper a circumstantial account is given of the geological structure and physical features of those parts of the country which the author visited: and the general result of the comparison he draws of both the eastern and western coasts and their islands, with the interior, is highly favourable to the hypothesis of a gradual rise of the land; every tract having, in its turn, been first a shoal in the sea, and then, for a time, a portion of the shore. This opinion is strongly corroborated by the testimony of the inhabitants, (pilots and fishermen more especially,) of the increased extension of the land, and the apparent sinking of the sea. The rate of elevation, however,

appears to be very different in different places : no trace of such a change is found in the South of Scania. In those places where its amount was ascertained with greatest accuracy, it appears to be about three feet in a century. The phenomenon in question having excited increasing interest among the philosophers of Sweden, and having especially excited the attention of Professor Berzelius, it is to be hoped that the means of accurate determination will be greatly multiplied.

January 15, 1835.

JOHN WILLIAM LUBBOCK, Esq., M.A., V.P. and Treasurer, in the Chair.

Second Essay on a general Method in Dynamics. By William Rowan Hamilton, Esq., Andrew's Professor of Astronomy in the University of Dublin, and Royal Astronomer of Ireland. Communicated by Captain Beaufort, R.N., F.R.S.

This essay is a sequel of the one which appeared in the last volume of the Philosophical Transactions, and which contained a general method for reducing all the most important problems of dynamics to the study of one characteristic function, or one central or radical relation. It was there remarked that many eliminations required by this method might be avoided by a general transformation, introducing the time explicitly into a part (S) of the whole characteristic function (V); and the first object of the present essay is to examine and develop the properties of this part (S), which the author designates by the term *Principal Function*. This function is applied by the author to problems of perturbation, in which he finds it dispenses with many laborious and circuitous processes, and furnishes accurate expressions of the disturbed configurations of a system by the rules of undisturbed motion, if only the initial components of velocities be changed in a suitable manner. Another manner of extending rigorously to disturbed, the rules of undisturbed motion, by the gradual variation of elements, in number double the number of the coordinates or other marks of position of the system, which was first invented by Lagrange, and was afterwards improved by Poisson, is considered in this second essay under a form rather more general; and the general method of calculation which has already been applied by the author to other analogous questions in optics and in dynamics, is now applied to the integration of the equations which determine these elements. This general method is founded chiefly on a combination of the principle of variations with those of partial differentials, and may furnish, when matured, a separate branch of analysis, which may be denominated the *Calculus of Principal Functions*. When applied to the integration of the equations of varying elements, it suggests the consideration of a certain *Function of Elements*, capable of being variously transformed, and which may be either rigorously determined, or at least approached to, by a corollary of the general method. With a view to illustrate these new principles, and more especially those connected